mental methods are perfect, or that well considered changes may not in some cases be wholly desirable. All I desire to do is to point out that the nostrum now offered is by no means a cure-all, and that the attainment of ideal conditions depends almost wholly on an honest recognition by the whole country, as represented by Congress and the executive, of merit, fitness and resulting permanency of tenure in the staff of the scientific bureaus.

WASHINGTONIAN.

WASHINGTON, January 16, 1897.

THE JURASSIC WEALDEN (TITHONIAN) OF ENGLAND.

PROF. O. C. MARSH has called again attention to the Wealden formation of England—an abnormal deposit, rather puzzling. Every observer working at geographical geology and general classification has been struck by an enigma in the otherwise classical classification of the strata of England. Between the Portland stone at the island of Portland and at Durstone bay, and the Lower Greensand of the Middle Cretaceous, we have a series of beds, mainly sands and clays, with some limestone and dirt in the inferior part, which has been called a fluvio-marine and fresh-water formation, of a thickness of about 1,500 or 2,000 feet, designated generally by the name of Wealden. The name of 'Weald formation, or Wealden,' was first introduced in the English classification by P. I. Martin in 1828 (*A Geological Memoir on a Part of Western Sussex*, p. 40, 4to, London).

Dr. William H. Fitton accepted it, and in his celebrated memoir, *Observations on some of the strata between the C_____ the Oxford oolite in the Southeast of England*, Trans. Geol. Soc. London, second series, Vol. IV., p. 103, London, 1836, gives a detailed account, dividing the Wealden into three great groups, called the Purbeck strata, Hastings sand and Weald clay proper.

Dr. Gideon A. Mantell is generally credited as the author of the stratigraphic position in English classification of the Wealden formation (*Illustrations of the Geology of Sussex*, 4to, London, 1827, and *A sketch of the Geological structure of the Southeastern part of Sussex*, Lewes, 1818). He puts it as the lowest part of the Cretaceous formation.

The classification of Mantell was generally accepted until November, 1849, when Edward Forbes observed at Portland and Swanage that Fitton and Mantell made mistakes, especially in regard to the Purbeck marble series, and, after some close and excellent observations, recognized that the Purbeck was Jurassic and not Cretaceous. As he humorously says in a letter to Ramsay: "The 'geology of England' may be 'done' by the old fellows, but it is not overdone yet." (*Memoirs of Edward Forbes*, p. 461, London, 1861.) Edward Forbes was the man to correct errors of classification in regard to the Mesozoic and Tertiary. He has no equal for sharp observations and correct conclusions. Unhappily he was not able to finish his work; his premature death in 1854 arrested completely the researches he inaugurated so well in Dorset and the Isle of Wight. Even his work, as he has entitled it, 'A Description of the Purbeck and Wealden fresh-water and fluvio-marine strata of Dorsetshire and the Isle of Wight, with comparative remarks on synchronous strata elsewhere' (Preface, p. vii., *On the Tertiary fluvio-marine formation of the Isle of Wight*, London, 1856), was never published; only a short notice was given to the public in the British Association Report for 1850, under the title 'On the succession of organic remains in the Dorsetshire Purbecks.' However, short as it is, the notice of Forbes brought the age of the Wealden once more before the English geologists, and one of them who knew best the Secondary or Mesozoic formations, the nephew of the celebrated 'Strata Smith,' Prof. John Phillips, of the University of Oxford, in his remarkable *Manual of Geology*,* pp. 282–318,

* Extract from a letter of Prof. John Phillips to Jules Marcou. * * * "As to the propriety of placing the Wealden in the Cretaceous I have my doubts. Certainly the fresh-water fossil remains, which otherwise are not characteristic of the age of strata, are not in favor of uniting the upper part of the Wealden with the Cretaceous, while the *Megalosaurus* and other Saurians, as well as the fishes and plants found in the Middle (Hastings Sands), protest loudly against the separation of the Wealden from the Oolites." JOHN PHILLIPS.

ST. MARY'S LODGE, YORK, July 23, 1887.

London, 1885, has placed the Wealden formation with its three groups—Purbeck beds, Hastings sand and Weald Clay—into his Oolitic (Jurassic) system.

This classification of John Phillips was not accepted by the Geological Survey of England and the Director-General, the late Sir Andrew C. Ramsay, in his excellent book, '*The Physical Geology of Great Britain*,' fifth edition, pp. 201–212, London, 1878, classifies the 'Purbeck and Wealden strata,' as Lower Cretaceous, saying that the Hastings sands and Weald clay are the fresh-water equivalents in time of the lower and middle part of the Neocomian of Switzerland; adding, 'an assumption' which 'is undoubtedly correct.' Such correlation is inacceptable, for paleontology, lithology and even stratigraphy are wanting entirely, and an 'assumption' cannot replace principles and rules of classification.

Meantime, the true Neocomian has been found in Yorkshire, northwest of Flamborough Head, near Speeton, and described with details and exact correlations by Prof. J. W. Judd in 1868 and 1870, and more recently by Mr. G. W. Lamplugh in 1889 and 1892. Prof. A. P. Pavlow, of the University of Moscow, first in collaboration with Mr. Lamplugh in 1892, and afterward alone in his paper, *On the Classification of the Strata between the Kimmeridgian and Aptian* (Quart. Journ. Geol. Soc., London, Vol. 52, pp. 542–554, London, April, 1896), has given correlations of the Wealden with the Speeton clay and Neocomian of western Europe and Russia. Prof. Pavlow places the Purbeck beds in the Jurassic formations and regards them as the equivalent of the Tithonian of southeastern France.

Now comes the paper of Prof. O. C. Marsh, first read in 1895 at the British Association at Ipswich, and afterward at the National Academy of Science, New York, meeting November, 1896, in which he says that on the vertebrate fauna the Wealden is Jurassic and not Cretaceous.

Many years ago Louis Agassiz had referred some fossil fishes from the Purbeck of England to species of the upper Jura of Switzerland and France. Lately Mr. Smith Woodward, according to Prof. Marsh, has found that the fossil fishes of the Wealden are of Jurassic types; and finally the paleobotanist, Mr. A. C. Seward, after a review of the Wealden plants, says that the evidence is in favor of 'the inclusion of the Wealden rocks in the Jurassic series.' Accordingly, the opinion of Prof. John Phillips, expressed as far back as 1855, is now indorsed by the reptilian fauna, by the fishes and by the fossil plants. Such a concourse of paleontological proofs must correspond with some geographic and stratigraphic facts in the districts of eastern England extending from the island of Portland to Speeton and Filey Bay, in Yorkshire.

During a prolonged visit at Weymouth, in 1870, I was surprised at the small thickness of the Portland stone (only 8 feet) in the celebrated Portland quarries, and at the great development of the Purbeck beds covering the whole Island. As far back as 1858 (*Sur le Néocomien dans le Jura*, etc., Genève) I called attention to the correlation of the Purbeck beds with what was called in France 'Calcaires Portlandiens,' or 'Calcaires de Salins' of Franche-Comté. Since those Portlandian limestones of the Jura have been studied with more detail and exactness in regard to their thickness and the fossils found in them, it is now certain that they constitute a group of strata all younger than the Portland stone of the isle of Portland. The latter are correlated and identical in every way with the 'Marnes Portlandiennes' or 'Marnes de Salins,' containing exactly the same fauna with its most characteristic fossil, the *Exogyra virgula;* and we have now an indisputable horizon, common to southeastern England and France, the Portland stone and the 'Marnes Portlandiennes,' or 'Marnes de Salins,' or zone of the *Exogyra virgula.*

In England before reaching the Speeton clay, undoubtedly Neocomian or Lower Cretaceous, we have above the Portland stone, the three groups of the Purbeck beds, the Hastings sand and the Weald clay. In the Jura Mountains, above the 'Marnes de Salins' with *Exogyra virgula*, we have the 'Calcaires de Salins,' or Portlandian limestones, composed of two groups; the inferior called: 'Portlandien inférieur,' containing a rich fauna, such as: *Nerinea Salinensis, Nerinea grandis, Natica Mar-*

cousana, *Natica Athleta*, *Trigonia Barrensis*, *Trigonia Boloniensis*, *Mytilus portlandicus*, *Mytilus Tombecki;* and finally the *Hemicidaris Purbeckensis* of Forbes. The second group at the very top of the Jurassic formation, called in Franche-Comté 'Dolomies portlandiennes' of Marcou (*Etudes géologiques sur la Franche-Comté septentrional*, *Le système oolitique*, par Albert Girardot, p. 369, Paris, 1896), contains also a special fauna, indicating at some places a brackish formation, such as: *Corbula*, *Anisocardia*, *Cyrena*, *Protocardia*, *Lucina*, *Corbicella and Gervilliana*. However, at Gray (Haute Saône) the fauna is entirely marine, and Prof. Etallon, who has given a detailed description of that portion of Franche-Comté, has called it 'Diceras Portlandian beds.' In both divisions, or groups, corals are common round Gray, Morteau, Pontarlier and Salins. The thickness of the two groups varies between 150 and 600 feet, according to the more or less denudation of the upper portion of the strata.

Prof. Albert Oppel, of Munich, had created, in 1865, his Tithonic, or Tithonian formation (*Die Tithonische Etage*, Zeitschr. deutschen geologischen Gessellschaft, Jahrg, 1865, pp. 535–558, Berlin) to designate a special form of the divisions of the upper Jura, such as the Purbeck strata, the Solenhofer Schiefer and the Portland kalk, of the Alpine area and of the Mediterranean basin; it was a happy name, meaning that the groups of beds containing paleontological precursor forms of the Cretaceous fauna can be considered as a forerunner formation, announcing the arrival of another great system. Many papers have been published since the premature death of Oppel, in November, 1865, on that important question, the most remarkable being by Colonel A. Toucas, entitled '*Etude de la faune des couches tithoniques de l'Ardèche*' (Bull. Soc. Géol. France, 3d series, Vol. XVIII., pp. 560–629, Paris, 1890), in which he showed the existence of three different faunas, called Lower Tithonic or Diphyakalk, Middle Tithonic or Ardescian, and Upper Tithonic or Berriasian-Puberkian.

In England nothing can be correlated with those six hundred feet of limestone deposited in the Jurassic sea of southeastern France, of the Swiss Alps, of the Tyrol, of Stramberg (Carpathes), of Andalusia (Spain), but the brackish and fresh-water deposits of the Wealden formation. At Speeton there is nothing like it. The Portland stone is lacking there, very likely destroyed by denudation, and the series of Speeton clay is decidedly Neocomian, as it has been amply proved by Messrs. Judd, Lamplugh and Pavlow. If we consult the geological map of England, we see that directly over the small Portland beds, only eight or ten feet thick, we have brackish and fresh-water deposits, at first containing a few marine beds with the *Hemicidaris Purbeckensis* of Forbes, then becoming exclusively fluviatile, extending southward of Dorsetshire and the Isle of Wight, turning northward in the English Channel, reaching again the *terra firma* at Hastings and its environs, covering in the form of a cut ellipse all the country of the Weald, between the North Downs and South Downs (Kent and Sussex counties). We have there a sort of gigantic fossil mound, the remnant of a great delta or estuary deposit, like those actually going on at the mouth of the Ganges or of the Amazon. Farther west than the Weald region that formation lies directly over the Portland stone in the vale of Wardour, and very likely it extended northward. At the end of the Jura epoch the dislocation which has emerged the Jura formation in England and on the continent of Europe put a stop to those fresh-water deposits, and, being emerged as dry land, denudation began to remove easily such loose materials as clay and sands, leaving only the large semi-elliptical patches of southeastern England. The denudation lasted as long as the Neocomian or Lower Cretaceous deposits were going on at Speeton and in France and Switzerland; then by a general subsidence, affecting the whole coast of eastern England, the sea of the Yorkshire coast invaded the whole country south, depositing on the beds of the Wealden formation, and in some parts over the beds of the Portland stone and Kimmeridge clay, the strata called Lower Green Sand, Gault, Upper Green Sand and Chalk. The proof that the green sand sea came after the denudation, and even complete removal in some places of the Wealden, is shown by the existence of Lower Green Sand west of Hastings, lying directly on the

Hastings sand, when generally it lay always on the Weald clay.

The change effected on land and sea areas at the end of the Jura period was on a very grand scale in Europe as well as in America; and the Neocomian or Lower Cretaceous was not deposited in many portions of central Europe, especially in England, except at the little corner of Speeton, on the Yorkshire coast; and in the United States the Neocomian, even more limited than in Europe, was confined to Texas, the Indian Territory and southern Kansas.

One word of explanation on the use in France and Switzerland of the name 'Puberckian,' to designate the upper Tithonic or Berriasian. From the beginning, in 1848 and 1859, I showed that the name was wrongly applied to strata much younger than the Purbeck beds of England. The position of the *Hemicidaris Purbeckensis*, found in the first beds of the Salins limestone, authorize the correlation of the Puberckian of England with the base of the calcaires porlandiens or Lower Tithonic of the Jura. And the Purbeckian of the Jura Mountains, so well described by Gustave Maillard in his well known monograph (*Mém. Soc. Paléont. Suisse*, Vol. XI., Genéve, 1884), correspond and is the equivalent of the lower portion of the Spilsby sandstone of Lamplugh and Pavlow; it is to say, it represents in the Jura the base of the Speeton clay of England, instead of being correlated to the Purbeck beds of the Island of Portland.

CORRELATION OF THE ENGLISH AND EAST FRENCH FORMATIONS.

	England.	*Eastern France.*	
Speeton.	Tealby limestone.	Urgonian or Upper Neocomian.	Neocomian.
	Tealby clay.		
	Claxby ironstone.	Hauterivian or Middle Neocomian.	
	Spilsby sandstone.	Valengian or Lower Neocomian.	
	Weald clay.	Jura—Portlandian limestone.	
	Hastings sands.	Ardéche—Upper, Middle and Lower Tithonic.	
	Purbeck beds.		
	Portland stone or *Exogyra virgula* zone.	Portlandian marls or *Exogyra virgula* zone.	

The correlation of the Wealden of England with the Tithonic of Franche-Comté, Switzerland, Savoy, Dauphiné, etc., is a beautiful work awaiting the careful researches of English geologists, and it is to be hoped that Mr. George William Lamplugh, now on the staff of the Geological Survey, who has done such good service at the geology of Speeton, will continue the work so well begun forty-eight years ago by Edward Forbes, so well traced in 1855 by John Phillips, and now so well advocated by Prof. O. C. Marsh.

Jules Marcou.

Cambridge, January 1, 1897.

COMPLIMENT OR PLAGIARISM.

The carefully prepared reply of Professors Beman and Smith (Science, p. 61) is disingenuous. Professor Halsted would gladly have printed in parallel columns the whole of his section, *Partition of a Perigon* (Elements, 151), which reappears in Beman and Smith, p. 179, as 'Partition of *the* Perigon.' As I made this section myself, I feel safe in asserting that it never before occurred in any geometry in the English language; but how could I ask the editor of Science to reprint it simply because Professors Beman and Smith had reprinted it? They deliberately say, "the *order* of the problems: To bisect a perigon, to trisect a perigon, to cut a perigon into five equal parts, to cut a perigon into fifteen equal parts," etc., "may be found in Newcomb's Geometry." (Science, p. 61.)

With Newcomb's book now in my hand, I assert that not one of these problems occurs therein. Next they assert that the word 'perigon' is 'found in several geometries.' If, in English, they mean Halsted's Metrical Geometry, 1881; Halsted's Elements, 1885; Halsted's Elementary Synthetic, 1892; Beman and Smith, 1895. The statement is disingenuous. If they knew of any other they would have named it.

George Bruce Halsted.

THE METEOROLOGICAL CONFERENCE AT PARIS. A CORRECTION.

On page 17 the last sentence of the first paragraph of my report should read as follows: "No one came from either Spain or Brazil, as was not the case at Munich, but Italy, Belgium, Canada and Mexico each sent a delegate to Paris, the two latter countries participating for the first time in an international meeting."